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Investigation of responses of plant mixture to different water stress regimes in a pot experiment

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Introduction

•Drought has been a worldwide concern for many years with an increased concern for some regions impacted by global warming

•The tolerance of plants to drought stress can be facilitated by increasing water uptake or decreasing water loss but only one of these can be expressed in a monoculture

• Having more than one species adapted to drought present in a mixture should provide better 'insurance' than monocultures

Objectives

•To determine if a mixture of plant species have higher net primary productivity than monoculture of a single species under conditions of water deficit?

•To determine which forage species has the best growth under conditions of water deficit?

Materials and Methods

Experiment locations

The study was conducted at SPARC-AAFC, in Swift Current, Saskatchewan.

Experiment treatment

•5 plant species from 3 functional groups were selected for testing

2 legume plants: alfalfa (ALF),
purple prairie clover (PPC)
2 grasses plants: crested wheatgrass (CWG)
blue grama (BG)
shrub: winterfat (WF)

•A randomized complete block design with 2 factors (species mixtures and water treatments) was used.

•3 different watering treatments: a well-watered treatment (100% of field capacity) and two water-stressed treatments (85 and 70% of field capacity).

•The experiment had three replications, each with 42 pots.

•The soil water content was maintained at 100, 85 and 70% by watering daily.

Acknowledgements

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Table 1. Above-ground biomass in the greenhouse for mono- and poly-cultures (unit: g)

Water treatment	100%	85%	70%	*P*	SEM
	----------Above-ground Biomass----------				
ALF	1.39ab(A)	0.86a(B)	0.69a(B)	<0.001	0.01
PPC	0.12g(A)	0.11e(A)	0.07f(A)	0.26	0.02
CWG	0.55ef(A)	0.44d(AB)	0.34de(B)	0.06	0.05
BG	0.77cde(A)	0.50d(B)	0.37cde(B)	0.02	0.07
WF	0.85cd(A)	0.81ab(A)	0.53abc(A)	0.23	0.10
ALF*PPC	1.30b(A)	0.82a(B)	0.47bcd(B)	0.01	0.10
ALF*CWG	1.53ab(A)	0.92a(B)	0.59ab(C)	<0.001	0.07
ALF*BG	1.57a(A)	0.88a(B)	0.52abc(C)	<0.001	0.05
PPC*CWG	0.49f(A)	0.40d(A)	0.40cde(A)	0.42	0.05
PPC*BG	0.60def(A)	0.53cd(A)	0.25e(B)	0.04	0.08
CWG*BG	0.54ef(A)	0.46d(A)	0.36cde(A)	0.36	0.08
CWG*WF	0.72cdef(A)	0.56cd(A)	0.45bcd(A)	0.12	0.08
BG*WF	0.82cd(A)	0.68bc(AB)	0.50bcd(B)	<0.05	0.07
PPC*BG*WF	0.90c(A)	0.69bc(A)	0.45bcd(B)	<0.01	0.06
P	<0.001	<0.001	<0.001		
SEM	0.09	0.06	0.06		

Note: different lower-case letter indicates significant difference of species; Capital letter is the significant difference of water treatment. α = 0.05

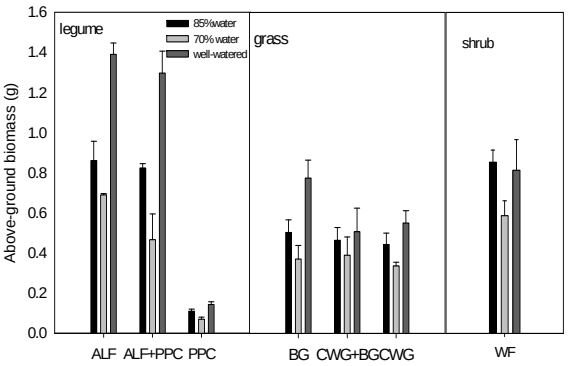

Figure 1. Above-ground biomass of different plant functional groups

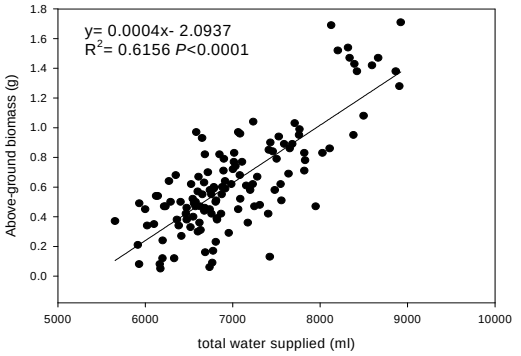

Figure 2. Temporal linear dependence of total water supplied with above-ground biomass by 126 pots

Results and discussion

▪Fourteen treatment types above-ground biomass was higher in well-watered treatment than in the other two lower water treatments (Table1), the exception was WF that had a higher biomass in the 85% field capacity treatment (0.85g, Table1) than in the field capacity treatment (0.81g Table1) although not statistically different. Our results are in a agreement with the statement: water is an important limiting factor to plant productivity globally and drought will reduce aboveground biomass for most species (Lambers et al., 1998).

▪Compared to other species combinations, the mixture of ALF and BG had the highest aboveground biomass in the field capacity treatment (1.57g, Table1). ALF as a N-fixing legume likely supplied N for enhanced growth of BG resulting in the greater biomass of ALF × BG under the higher moisture conditions (Schellenberg 2002). ALF is also noted as a high water user.

▪ Not all mixtures improved plant above ground biomass for plant functional groups (Fig.1). The ALF containing mixtures always had the highest biomass under well-watered treatment.

▪Above-ground biomass (R^2=0.6156, *P*<0.0001, Fig 2) increased with increasing total water supplied.

Conclusions

Increasing potential for drought will reduce aboveground biomass. The aboveground biomass of mixtures were always higher than monoculture for all water treatments, except ALF. Biomass trends for all water treatments were ALF>WF>BG>CWG>PC, as the plants mature one would expect this ranking to change but this ranking provides a possible indication of relative competitiveness. Compared with the other mixtures under drought condition, the mixture of ALF × CWG had the highest biomass under the two water-stressed treatments.

Key references

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